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ORIGINAL ARTICLE

Assessment of Service Quality in Teaching Hospitals of Yazd University of Medical Sciences: Using Multi-criteria Decision Making Techniques

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Abstract
Objectives: Hospitals as integrated parts of the wide-ranging health care systems have dominant focus on health care provision to meet, maintain and promote people's health needs of a community. This study aimed to assess the service quality of teaching hospitals of Yazd University of Medical Sciences using Fuzzy Analytical Hierarchy Process (FAHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).
Methods: A literature review and a qualitative method were used to obtain experts' viewpoints about the quality dimensions of hospital services to design a questionnaire. Then, using a self-made questionnaire, perceptions of 300 patients about the quality of delivered services were gathered. Finally, FAHP was applied to weigh each quality dimension and TOPSIS method to rank hospital wards.
Results: Six dimensions including responsiveness, assurance, security, tangibles, health communication and Patient orientation were identified as affecting aspects of hospital services quality among which, security and tangibles got the highest and lowest importance respectively (0.25406, 0.06883). Findings also revealed that in hospital A, orthopedics and ophthalmology wards obtained the highest score in terms of quality while cardiology department got the lowest ranking (0.954, 0.323). In hospital B, the highest and the lowest ranking was belonged to cardiology and surgical wards (0.895, 0.00) while in hospital C, surgical units were rated higher than internal wards (0.959, 0.851).

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Conclusion: Findings emphasized that the security dimension got the lowest ranking among SERVQUAL facets in studied hospitals. This requires hospital executives to pay special attention to the issue of patients' security and plan effectively for its promotion.

1. Introduction

As health care organizations are directly responsible for people's lifesaving, delivery of high quality services has got a particular importance to avoid them from preventable deaths and harmful injuries. Quality is a multidimensional concept with patient satisfaction as one of the important facets. Analyzing the quality of health care services from patients' viewpoint has beneficial implications for a hospital such as being helpful for strategy making in quality improvement [1,2]. Provision of health services in compliance with patients' needs and expectations increases the organizations' chances to survive in today's competitive environment [3]. To date, several definitions were used in regard to healthcare quality. British National Health System (NHS) defines healthcare quality as to provide the right services to the right people at the right time, with the right approach and in line with population affordability [4]. Gronroos introduced a two dimensional quality model comprised of technical and functional aspects [5]. Patients have difficulty in evaluating technical quality while functional sides can be easily evaluated by them [6]. Thus, patients evaluate the quality of health care services based on interpersonal and environmental factors, which offers to satisfy the requirements of patients in addition to their acceptance [7].

Several methods have been used to measure the quality of health services which are often faced with uncertainty [8,9]. To overcome such a problem and resolve ambiguities related to human judgements, the Multi-criteria Decision Making Models (MCDM) and fuzzy theories have been introduced in performance evaluation [10,11]. AHP is a structured technique for analyzing complex situations based on mathematics and psychology developed by Thoms L. Saaty in the 1970s. Those who apply AHP method, first break their decision problem down into a hierarchy of more realized subproblems, each of which can be analyzed individually. When the hierarchy is made, the decision makers thoroughly evaluate various factors by comparing them to each other in regard to their impact on an element above them [12]. TOPSIS model which has been proposed by Hwang and Yoon in 1981 [13] is a multi-criteria decision making model used to compare a set of choices by determining weights for each measure [14–16]. In this study, we tried to use MCDM to assess the service quality of teaching hospitals of Yazd University of Medical Sciences using Fuzzy Analytical Hierarchy Process (FAHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

2. Materials and methods

This was a descriptive, cross sectional study conducted in 2013 in hospitals affiliated by Yazd University of Medical Sciences. First, a literature review was done to extract quality dimensions in a SERVQUAL model (Figure 1). Then, the initial draft was revised based on 42 experts' viewpoints (including hospital managers, hospital technical employees and faculty members of healthcare management departments) and finalized through a qualitative method analyzing the data obtained from an expert panel. Finally, 29 sub-dimensions were selected which were categorized in six aspects. Then, a fuzzy AHP (analytic hierarchy process) was structured to evaluate the hospitals service quality and weigh identified dimensions.

As mentioned above, despite the widespread application of AHP in many decision-making problems, there is a criticism about the technique which focuses on its failure in managing uncertainties. To overcome such a dilemma, FAHP has been developed [17,18]. The method allows decision makers to include the uncertain situations in their judgments [19] (Figure 2).

In second phase of the study, a questionnaire was developed based on the literature review and expert viewpoints to analyze patients' perceptions about health services quality of Yazd hospitals. The Questionnaire was comprised of two sections, section A contained socio-economic characteristics of patients and section B encompassed 29 questions with 5-point Likert scaling system related to research objectives of the study. Content validity of the questionnaire was confirmed by experts and its reliability was tested through Cronbach's alpha which calculated as 0.92. The research population was inpatients of three training hospitals affiliated by Yazd University of Medical Sciences. Patients in ICU and pediatric wards were excluded due to inability to contribute in research. A total of 300 patients (considering d = 0.22, α = 0.05, SD = 1.9 and $n=\frac{(z_{1-\alpha/2})^2\times(SD)^2}{d^2}$) with at least 2 days length of stay contributed in the study. To collect the data, simple random sampling was used, that the admitted patients to each hospital, as an allocation proportional the number of patients and wards, samples are extracted for each hospitals and questionnaires and wards were distributed. Data gathered from completed questionnaires were analyzed using TOPSIS method and Excel software. Excel software is one of the most functional Microsoft Office

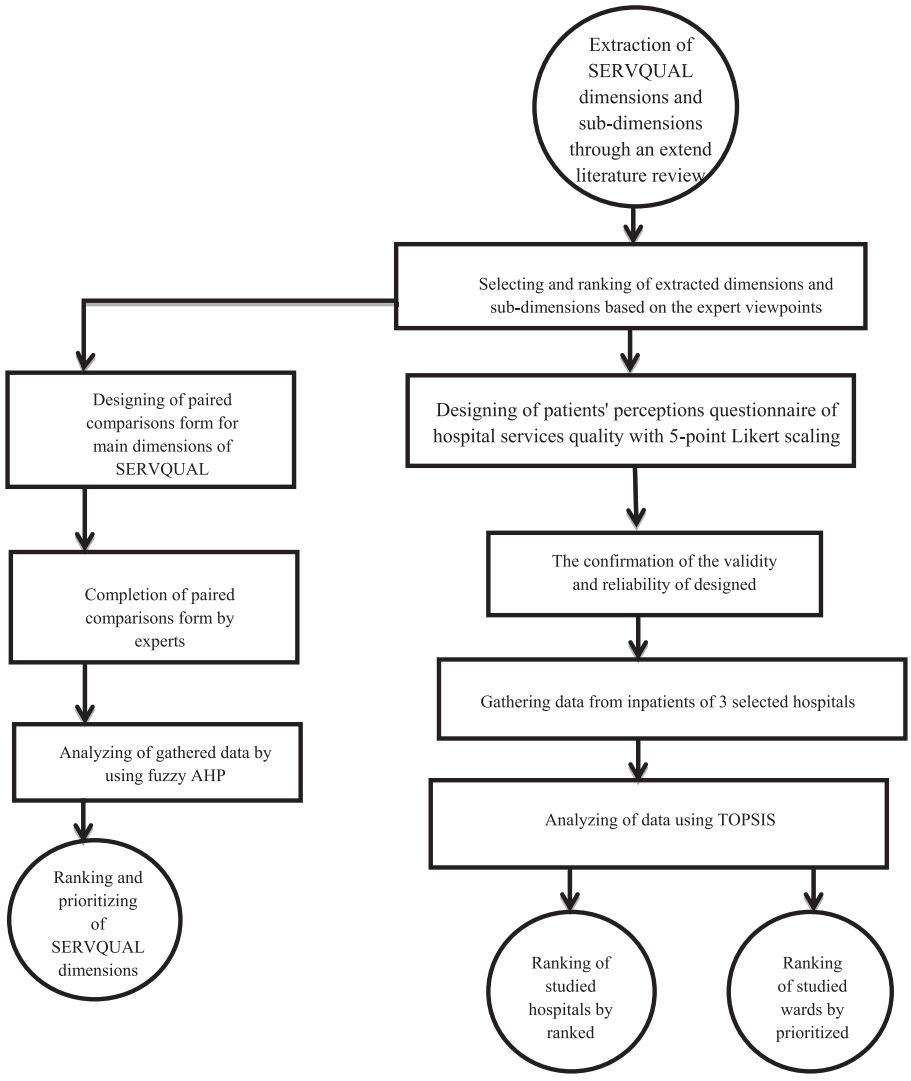


Figure 1. Study design.

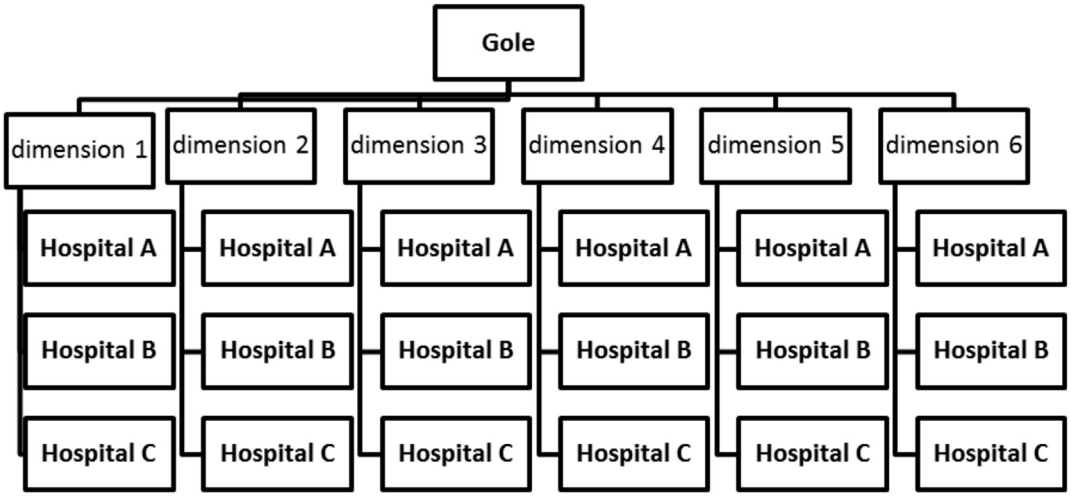


Figure 2. Hierarchical tree of decision-making for the subject of study.

software. Excel is a Spread Sheet software and is in the office applications.

Problem solving by TOPSIS method was done in seven steps as following:

Step one: Draw the fuzzy adaptive matrix of people's viewpoint about the importance of each SERVQUAL dimensions.

$$\tilde{D}=\begin{bmatrix}\tilde{x}_{11} & \tilde{x}_{12} & \dots & \tilde{x}_{1n}\\ \tilde{x}_{21} & \tilde{x}_{22} & \dots & \tilde{x}_{2n}\\ \vdots & \vdots & \dots & \vdots\\ \tilde{x}_{m1} & \tilde{x}_{m2} & \dots & \tilde{x}_{mn}\end{bmatrix}$$

$$\tilde{W}=[\tilde{w}_1,\tilde{w}_2,\dots,\tilde{w}_n]$$

In this matrix:

i: Number of components
j: Number of respondents

$\tilde{X}_{ij}$: i-th individual's viewpoint about the j-th component which has been calculated as following:

$$\tilde{X}=(a_{ij},b_{ij},c_{ij})$$

$\tilde{W}_{ij}$: The rate of individual's viewpoint's importance which is expressed as following:

$$\tilde{W}_j=(w_{j1},w_{j2},w_{j3})$$

It should be noted that in this study, because of the same level of experts viewpoints' importance, $\tilde{W}_{ij}$ for the whole target population was defined as following:

$$\tilde{W}_j=(1,1,1)\,\forall j\in n$$

Step two: Scale unification of decision matrix and convert the fuzzy decision matrix of individuals' viewpoints to a fuzzy unified matrix. To obtain the matrix following functions were used.

$$\tilde{R}=[\tilde{r}_{ij}]_{m\times n}$$

$$\tilde{r}_{ij}=\left(\frac{a_{ij}}{c_j^*},\frac{b_{ij}}{c_j^*},\frac{c_{ij}}{c_j^*}\right)$$

In this function (relationship) ci for each individual is equal to:

$$c_j^*=\max_i c_{ij}$$

Third step: Create a fuzzy weighted unified scale matrix with assuming of wi vector as the algorithm entrance, so that:

$$\mathrm{i}=1,2,\dots,\mathrm{m},\quad \mathrm{j}=1,2,\dots,\mathrm{n},\quad \tilde{V}=[\tilde{v}_{ij}]_{m\times n}$$

$$\tilde{v}_{ij}=\tilde{r}_{ij}\cdot\tilde{w}_j$$

Fourth step: Define a fuzzy positive ideal (*FPIS*, A^+) and fuzzy negative ideal (*FNIS*, A^-) for the components.

$$A^+=(\overset{*}{\tilde{v}}_1,\overset{*}{\tilde{v}}_2,\dots,\overset{*}{\tilde{v}}_n)\quad A^-=(\bar{\tilde{v}}_1,\bar{\tilde{v}}_2,\dots,\bar{\tilde{v}}_n)$$

In this study, we used the fuzzy positive ideal and negative ideal which has been introduced by Chen [20].

$$\overset{*}{\tilde{v}}_j=(1,1,1)\quad \bar{\tilde{v}}_j=(0,0,0)$$

Fifth step: Calculate sum of the distances related to each component from fuzzy positive and negative ideal: If A and B are two fuzzy number as follows, then the distance between theses fuzzy numbers obtained by the following equation.

$$\tilde{B}=(a_2,b_2,c_2)\ \tilde{A}=(a_1,b_1,c_1)$$

$$D(A,B)=\sqrt{\frac{1}{3}\left[(a_2-a_1)^2+(b_2-b_1)^2+(c_2-c_1)^2\right]}$$

Given the above description about calculating method of distance between two fuzzy numbers, the distance of each component from positive and negative ideals can be calculated as below:

$$d_i^*=\sum_{j=1}^{n}d(\tilde{v}_{ij}-\overset{*}{\tilde{v}}_j)\quad i=1,2,\dots,m$$

$$d_i^-=\sum_{j=1}^{n}d(\tilde{v}_{ij}-\bar{\tilde{v}}_j)\quad i=1,2,\dots,m$$

Sixth step: Calculate the relative proximity of i-th component from the positive ideal. Relative proximity is defined as:

$$CC_i=\frac{d_i^-}{d_i^*+d_i^-}\quad i=1,2,\dots,m$$

Seventh step: Rank an assumed problem according to the descending order of Ci [21,22].

3. Results

3.1. Demographic characteristics of patients

Results showed that most of the participants (50.3%) were male and (36.6%) belonged to 25−30 age group with the highest frequency. Most patients were under diploma (48%) and 90% were insured.

3.2. Extracting the affecting dimensions of SERVQUAL

As shown in Table 1, six dimensions including responsiveness, assurance, security, tangibles, health communication and patient-orientation were identified as key dimensions of service quality provided in hospitals.

Table 1. Dimensions and sub-dimensions of SERVQUAL.

No	Dimension	Definition	Sub-dimensions
1	Responsiveness	Willingness to help customers and sensitivity to solve their problems	– Evaluation and treatment – Service appropriateness – Promptness of service delivery – Continuity of care – Service availability – Service accessibility
2	Security	Freedom from danger, risk or uncertainty: personal safety in the time of participation in customer services process	– Personal privacy – Confidentiality of patients' information
3	Assurance	Skills and competencies of providers which induces confidence and trust in patients (organization ability to fulfill its promises accurately and consistently)	– Commitment – Safety in service delivery – Accountability – Trust – Skill, ability and competency of providers – Professionalism
4	Tangibles	Appearance of physical facilities, equipment, personnel	– Cleanness – Environmental Conditions – Attractiveness
5	Health communication	Ability to communicate effectively with patients	– Understanding customers' needs – Decent and respectable communication – Empathy – Emotional support, attention, companionship – Notification – Patient involvement in treatment
6	Patient-orientation	Valuing the customer as an affecting element in the organization's success so that it increases his/her desire to revisit the organization or positive mouth advertising	– The desire to reuse hospital services – Customer Loyalty – Customer Satisfaction – Patients' comfort and convenience

3.3. Extracting the weights and importance coefficients of hospital SERVQUAL dimensions

Importance coefficients of each dimension was extracted based on the paired comparisons of aspects in relation to the identified target using the designed questionnaire for paired comparisons and through FAHP (Table 2).

Table 2. Importance coefficients of SERVQUAL dimensions using FAHP.

Dimensions	Importance coefficient	Priority
Responsiveness	0.11024	5
Security	0.25406	1
Assurance	0.25219	2
Tangibles	0.06883	6
Health communication	0.14833	4
Patient-orientation	0.16636	3

3.4. Ranking quality dimensions in hospitals

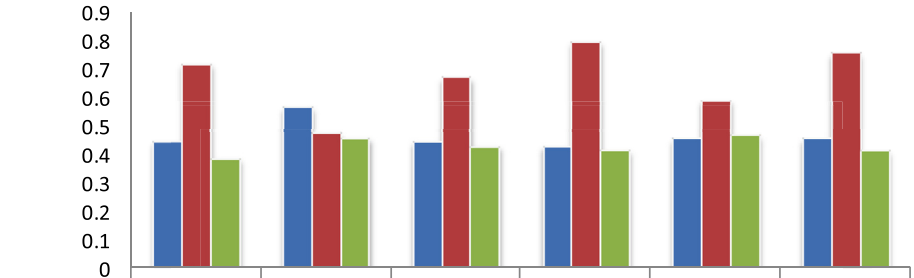
As depicted in bellow figure, hospital A obtained the highest ranking in security and lowest in health communication. While, hospital B achieved the highest ranking in all dimensions except for security and hospital C did not obtain first ranking in any dimension (see Figure 3).

3.5. Ranking of hospitals' wards using TOPSIS

Figure 4 presents that at hospital A, Orthopedic and Ophthalmology wards had the highest Ci and Cardiology had the lowest, respectively (0.954 vs. 0.323). In hospitals B and C, cardiology and orthopedic units obtained the highest (0.895 and 0.970) and surgery and internal wards achieved the lowest Ci scores (0.000 and 0.851).

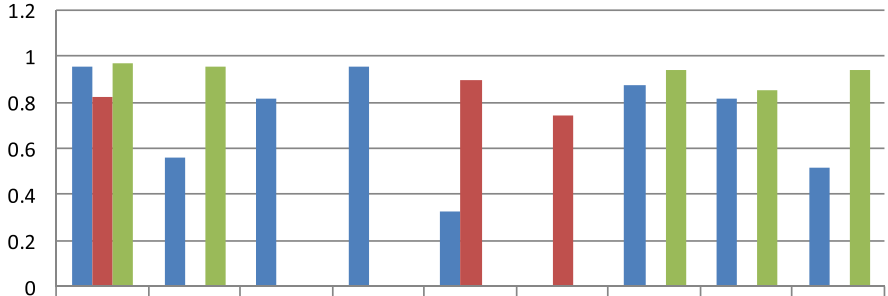
3.6. Ranking of quality dimensions in hospital wards using TOPSIS

Table 3 shows the Ci values and each dimension's ranking in different wards of hospital A. As seen in this



	Responsiveness	Security	Assurance	Tangibles	Health communication	Patient-orientation
Hospital A	0.445	0.564	0.445	0.428	0.455	0.455
Hospital B	0.718	0.471	0.671	0.796	0.591	0.755
Hospital C	0.385	0.458	0.428	0.414	0.466	0.412

Figure 3. Results of dimensions analysis in hospitals using TOPSIS.



	Orthopedics	Surgery	ENT	Ophthalmology	Cardiac	Ob&Gyn	Neurology	Internal	Urology
Hospital A	0.954	0.556	0.819	0.954	0.323		0.878	0.819	0.514
Hospital B	0.823	0			0.895	0.744			
Hospital C	0.97	0.959					0.94	0.851	0.94

Figure 4. Results of data analysis of hospitals using TOPSIS.

figure, in orthopedics ward, tangibles achieved highest and security achieved lowest Ci values. In ENT ward, this values allotted to responsiveness and security. In Ophthalmology ward, assurance achieved highest and security achieved lowest Ci values while assurance and security had the highest and lowest Ci in internal ward respectively. In necrology ward patient-orientation and security, in urology assurance and patient-orientation and in cardiology assurance and tangibles obtained the highest and lowest Ci values.

Table 3. Ci values and the rank of SERVQUAL dimensions in hospital A wards.

Hospital A																
Wards	Surgery		Cardiac		Urology		Neurology		Internal		Ophthalmology		ENT		Orthopedics	
Dimensions	Rank	Ci	Rank	Ci	Rank	Ci	Rank	Ci	Rank	Ci	Rank	Ci	Rank	Ci	Rank	Ci
Patient-orientation	2	0.801	5	0.41	6	0	1	1	2	0.79	5	0.507	4	0.56	5	0.34
Health communication	6	0	4	0.5	5	0.16	5	0.47	5	0.38	4	0.58	5	0.17	4	0.71
Tangibles	1	1	6	0	4	0.205	2	0.85	4	0.69	3	0.95	2	0.89	1	1
Assurance	5	0.460	1	1	1	1	3	0.71	1	1	1	1	3	0.65	2	0.84
Security	4	0.494	3	0.66	3	0.57	6	0	6	0	6	0	6	0	6	0
Responsiveness	3	0.754	2	0.92	2	0.61	4	0.6	3	0.72	2	0.97	1	1	3	0.75

As presented in Table 4, at hospital B, tangibles and security achieved the highest and lowest values of Ci in 3 wards including cardiology, Obstetrics, Gynecology and surgery. Also, orthopedics ward had the highest Ci value in patient orientation dimension and the lowest in security.

In hospital C, responsiveness and security achieved the highest and lowest Ci values in urology and surgery wards. In neurology ward, assurance and tangibles obtained the highest and lowest Ci values. Also, orthopedics ward had the highest and lowest Ci in assurance and security and finally, patient orientation and security achieved the highest and lowest Ci in internal ward (Table 5).

Comparing the quality of services provided among under study hospitals, results indicated that hospital B Results of hospitals ranking using TOPSIS shows hospitals B, A and C respectively rank first to third (Table 6).

Table 6. Results of hospitals ranking using TOPSIS.

Rank	Hospital	Ci
1	B	0
2	A	0.3833
3	C	0.7252

4. Discussion

Quality is regarded as an important factor in all organizations especially those encountering with patients' life and health condition. In this study we used multi-criteria decision making technique to evaluate and rank different wards of training hospitals in Yazd University of Medical Sciences. In the first phase of study, six dimensions including responsiveness, assurance, security, tangibles, health communication and patient-orientation were identified as SERVQUAL dimensions. Similarly, Kahraman in his study has identified SERVQUAL dimensions as tangibles, assurance, responsiveness, reliability, empathy and professionalism [11,23]. Findings of Narang study confirmed that employees' behavior, adequacy of resources and health services accessibility could also affect quality of health services [23]. Differences in SERVQUAL dimensions extracted in our study and similar researches could be due to the varieties of scopes regarded in quality measurements.

Hariharan et al, in a study carried out in specialized hospitals introduced AHP technique as a useful tool for measuring performance based on multi-aspects

Table 4. Ci values and the rank of SERVQUAL dimensions in studied wards of hospital B.

Hospital B								
Wards	Surgery		Orthopedics		Obstetrics		Cardiac	
Dimensions	Rank	Ci	Rank	Ci	Rank	Ci	Rank	Ci
Patient orientation	4	0.83	1	1	2	0.97	2	0.98
Health communication	5	0.54	5	0.69	5	0.55	5	0.46
Tangibles	1	1	3	0.96	1	1	1	1
Assurance	3	0.91	4	0.95	4	0.95	4	0.87
Security	6	0	6	0	6	0	6	0
Responsiveness	2	0.94	2	0.98	3	0.95	3	0.96

Table 5. Ci values and the rank of SERVQUAL dimensions in wards of hospital C.

Hospital C										
Wards	Internal		Orthopedics		Neurology		Urology		Surgery	
Dimensions	Rank	Ci	Rank	Ci	Rank	Ci	Rank	Ci	Rank	Ci
Patient-orientation	1	1	3	0.8	4	0.62	4	0.76	4	0.55
Health communication	5	0.44	5	0.51	2	0.72	5	0.73	5	0.32
Tangibles	3	0.72	2	0.87	6	0	3	0.89	3	0.81
Assurance	2	0.77	1	1	1	1	2	0.96	2	0.95
Security	6	0	6	0	5	0.26	6	0	6	0
Responsiveness	4	0.62	4	0.65	3	0.67	1	1	1	1

dimensions [24]. Results of fuzzy AHP technique and experts' opinions in our study revealed that security achieved the highest importance while Gülçin et al. mostly focused on reliability and responsiveness as key dimensions of professionalism, interaction and accuracy [25]. Still, a research conducted in Turkey entitled strategic analysis of healthcare quality using fuzzy AHP, introduced empathy as the most important dimension [12].

Findings related to hospital wards ranking by TOPSIS method were in consistent with previous studies. A study in China showed that Obstetrics and Gynecology achieved the highest and ICU the lowest ranking of SERVQUAL [14]. Another research aimed to evaluate quality of medical care through TOPSIS reported surgical unit in a proper condition in terms of SERVQUAL which was confirmed by a study conducted in ten non-for-profit hospitals in China for a similar purpose [15,26].

Although responsiveness and tangibles are key functions of all health systems, they have got the least importance in our study from experts' viewpoints. Responsiveness includes some areas such as respect, individuals' dignity, patient's participation in medical care decisions and acknowledgment of non-medical needs which indirectly affect treatment effectiveness and patients' satisfaction. Therefore, much more emphasis must be given to such dimensions. Some studies have confirmed the importance of tangibles comparing to other ones [12,27]. Considering the mandatory nature of hospitalization and special circumstances which patients deal with (like being away from family and experiencing unfamiliar environment) and mainly cause psychological tension for them, tangibles play an important role in providing a pleasant life in hospitals.

Multi-criteria decision-making techniques are appropriate methods for prioritizing the affecting factors of health services' quality. Therefore, policymakers can use them for planning and improving the delivery of health services. Comparisons of the results obtained from ranking the SERVQUAL dimensions based on experts' viewpoints and implementation of fuzzy AHP analyzing patients' perspectives about service quality revealed that although security recognized as an important aspect of SERVQUAL from experts' viewpoints, it has got the lowest ranking among SERVQUAL dimensions in studied hospitals. Findings from open-ended questions revealed that respectful behavior, addressing non-medical needs of patients, physicians' attention to treatment, accountability of care team and cleanliness of the hospital environment were among key items which had been noted as the strengths of studied hospitals. On the other hand, issues such as absence of medical and nursing students on the bedside during the examination time, inadequateness of medical equipment, inappropriate behavior of clinical staff, insufficient number of nurses and service personnel especially in evening and night shifts and lack of transparency about service costs were among the items which had been considered as hospitals' weaknesses. Therefore, it is suggested to provide sufficient number of medical manpower and equipment for each hospital wards in addition to obtain informed consent from patients prior to any clinical intervention and train hospital staff on how to behave properly with patients. As a result, application of quality improvement strategies can lead to patients' loyalty.

At the end, it should be noted that our study had some limitations such as difficulty in having access to some experts and exclusion of some patients during the study because of their impending doom.

Conflicts of interest

Authors declared no conflict of interests.

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